

IMPACT OF CLASSROOM FURNITURE DESIGN ON BODY DISCOMFORT OF SCHOOL CHILDREN

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ABSTRACT

A classroom is considered to promote good health and safety when it gives schoolchildren a greater control over their own health. A sample of 150 students (81 boys and 69 girls) of 9th standard was selected to collect the data on perceived level of pain discomfort experienced while using the existing classroom furniture. A questionnaire with body map was administered at three different time intervals of a day. The results revealed that higher percentage of boys (54.32%) and girls (49.28%) experienced slight pain in their neck region at the end of school closing time. Also the onset of pain in the lower back was increased gradually from slight pain in the morning session (30.00%) to moderate pain at the end of school closing time (36.67%). The perceived level of pain discomfort experienced by majority of selected boys and girls while using developed prototype classroom furniture was found to be no pain throughout the day. The perceived level of pain for both the genders between the two types of furniture was found to be significant at 1 per cent level. It indicated that both boys and girls significantly experienced more pain in the existing furniture than in developed classroom furniture. It can be concluded that there is a need to introduce ergonomically designed classroom furniture for improved comfort of the users.

KEYWORDS: Discomfort, Classroom Furniture, Ergonomics & Pain

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INTRODUCTION

Children spend the overwhelming majority of school time in a sitting position. They may sit for 60 minutes (Paulsen and Hensen, 1994) or even longer without a break. Maintaining the same posture for long period is hard on the human body. Inadequate classroom furniture is frequently taken to be the reason of severe posture problems in adulthood. Therefore, chairs and desks used by children for considerable time need to be evaluated carefully (Schroder, 1997). A growing body of research indicates that school children report high rates of discomfort, particularly in the neck and back. Such musculo-skeletal symptoms often impair children's comfort and long-term health. Many researchers have showed that awkward and constrained sitting postures and poorly designed classroom furniture are important contributors to children's musculo-skeletal discomfort (Karwowski, 2006). Furniture design is related to issues such as back pain, posture and obesity and should be understood as one aspect of a multi-dimensional issue (Leuder, 2007). The posture adopted in classroom furniture also plays a main role in leading to musculoskeletal discomfort or pain. Prolonged static kyphotic sitting without use of a backrest was related to self-reported back or neck pain in school children (Geldhof *et al.*, 2007). Murphy

et al. (2007) found significant association between neck pain of school children and school furniture features such as chair height being too low and also family history of low back pain, previous treatment for musculoskeletal disorders. In the comparison of students anthropometry and existing classroom furniture dimensions, students reported discomfort in shoulders, wrist, knee and ankle regions (Savanur *et al.*, 2007). Dhara *et al.* (2009) evaluated the health complaints of rural school children and found that a higher percentage of respondents complain about problems in the upper leg and hip joints than in other parts of the lower limbs. The occurrence of shoulder joint problems gradually decreases with the children's increasing age. Back problems were found to be more prevalent than in lower grades. The number of children suffering from finger and palm problems increased with higher grades. They concluded that appropriate design of classroom furniture might be helpful for reducing the health complaints. Ismail *et al.* (2009) have conducted a study on association between ergonomic risk factors, RULA score, and musculoskeletal pain among school children. Their sample size consisted of 229 school pupils from Malaysia. The study results showed that high prevalence of MSD (68%) among schoolchildren aged 11 years old than school children (36.4%) of 8 years old. Most of the 5th grade students (62.2%) experienced upper MSD like neck pain (22.75%), shoulder pain (16.8%), elbow pain (25%), arm pain (5%), upper back pain (6.7%) and lower back pain (8.4%) compared to 2nd grade students (36.4%) experienced upper MSD. They also revealed one of the main risk factor of upper MSD among school children was the duration of home activities such as using PC/TV that exceeded 2 hours per day. They concluded that combination of risks lead to high increase of MSD among school children in Malaysia.

METHODOLOGY

The aim of the study was to study the impact of classroom furniture design on school children body discomfort. The study was conducted in Dharwad city of Karnataka. The selection of High schools was based on purposive sampling. A total sample of six high schools (3 government schools and 3 private schools) was selected for the study. From the selected high schools, a sample of 150 students (81 boys and 69 girls) of 9th standard was selected to collect the data on their perceived opinion with respect to the existing classroom furniture design. A pre-structured questionnaire was administered three times a day *ie.*, five minutes prior to the three intervals of a school working day *viz.*, before short break time (BSBT), before lunch break time (BLBT) and before school closing time (BSCT) to the respective students to collect information on the perceived level of pain discomfort experienced while using the existing classroom furniture and developed prototype classroom furniture. The existing classroom furniture dimensions for bench and desk were also recorded by using non-stretchable metallic measuring tape. Dimensions recorded were bench height, bench depth, bench width, backrest height, backrest width, seat slope, backrest slope and thigh clearance height. For desk, dimensions such as desk height, desk length, desk width and desk top slope were considered. The collected data were analyzed for impact of furniture design.

Ergonomically Developed Prototype Classroom Furniture

As per the students' recommendation, the proposed classroom furniture design was of individual chair and table with height adjustability feature in chair seat, chair backrest and table. The special feature of the developed furniture design is of adjustable type design. The adjustable design facilitates and accommodates range of users such as from 5th percentile to 95th percentile users. In the present study, to overcome the gender difference, upper limits of the design parameters were determined by using the 95th percentile values of boys and lower limits were determined by using the 5th percentile values of girls. Provision of separate tie back cushions for the chair seat and backrest was designed. The tabletop was tilted to 10°

and provision of side metal basket to keep books and other belongings of the students were designed.

Chair Design

The range of adjustability for seat height was considered from 5th percentile data of girls to 95th percentile of boys' popliteal height. It was given height adjustability, so that both the smaller popliteal height users and the greater popliteal height users will find the seat height comfortable by adjusting it to their required height. The 5th percentile buttock-popliteal length data of girls was used to determine the chair seat depth, as this will accommodate the greatest number of user, those with shorter buttock – popliteal lengths, as well as those with greater popliteal lengths. To determine the seat width, 95th percentile data of boys' hip breadth was used. For backrest height adjustability range, data of 95th percentile of the upper lumbar height of boys to 5th percentile value of the lower lumbar height of girls was considered. For the backrest width, 95th percentile of the shoulder breadth of boys was used. The angle between the seat and backrest planes was mentioned as backrest angle and it was determined as 100°. The seat plane angle was selected as 0°, as per recommendations of BIS (IS 4837 - 1990) for the school students.

Table Design

To determine the desk height, sum of popliteal height and sitting elbow height measurements were used. The lowest range of table height was determined with the data of 5th percentile of popliteal height and the sitting elbow height of girls and the highest range of the table height was determined with the data of 95th percentile of popliteal height and the sitting elbow height of boys. The 95th percentile data of elbow-fingertip length of boys was used to design the table depth. The 95th percentile data of the elbow-elbow breadth of the boys was taken into consideration for table length. The legroom clearance was determined by using 95th percentile data of thigh clearance height of boys. To determine the horizontal knee space under the table, 95th percentile data of buttock – knee length of boys was used.

RESULTS AND DISCUSSIONS

Musculo-Skeletal Pain Expressed by School Children

Data on perceived level of pain among selected ninth standard high school children while using their existing classroom furniture was collected on three different intervals of a working day *viz.*, Before Short Break Time (BSBT), Before Lunch Break Time (BLBT) and Before School Closing Time (BSCT). Five point scale was used for exploring the degree of discomfort *viz.*, No pain (1), Slight pain (2), Moderate pain (3), Severe pain (4) and Very severe pain (5). Table 1 presents the gender wise percentage distributions of discomfort experienced by the students.

Neck: It can be observed from the data that high percentage of boys (49.38%) and girls (68.12%) reported no pain in their neck region BSBT in the morning while more than one-fourth of boys (33.33%) and girls (28.99%) reported slight pain followed by less percentage for moderate pain (11.11%) and very severe pain (1.23%) among boys. However, there was an increase in the number of students (boys - 53.09%; girls – 46.38%) suffering from slight pain before lunch break time (BLBT). The onset of slight pain in the neck region was sustained for the students (boys – 54.32%; girls – 49.28%) up to school closing time. About 16.05 per cent of boys and 11.59 per cent of girls faced moderate pain at the end of the working day.

Shoulder: About 20.99 per cent of boys expressed slight pain during BSBT and the percentage increased to 33.33 per cent in the afternoon whereas in the evening school closing time it decreased to 27.16 per cent, experiencing slight pain. However, girls' experiencing slight pain was more than boys, it was 24.64 per cent before short break and 34.78 per

cent in the lunch break and reduced to 27.54 per cent in the evening.

Forearm: Less than one-fourth of students felt slight pain to moderate pain in their forearm at short break time. Before lunch break time the percentage of students who suffered slight pain was increased to 28.40 per cent for boys and 33.33 per cent for girls. Further it was raised to 34.57 per cent for boys and 36.23 per cent for girls at the end of the school closing time.

Upper Back: High percentage of boys (51.85%) and girls (76.81%) indicated that there was no pain in the upper back during BSBT. An equal percentage of boys experienced slight pain (19.75%) and moderate pain (19.75%) in their upper back during BSBT whereas about 15.94 per cent of girls expressed slight pain and very less number of girls (5.80%) felt moderate pain. The percentage of boys (27.16%) and girls (26.09%) who reported slight pain increased at BLBT. Also the percentage of boys (23.46%) and girls (11.59%) suffered from moderate pain was found to be increased at BLBT. The onset of pain was found to be sustained and increase in percentage of students (boys - 29.63% and girls -24.64%) reported moderate pain at school closing time was noticed.

Lower Back: Among different body parts, percentage of students who experienced slight to severe pain was found to be higher for the lower back region. After continuous sitting on the existing classroom furniture of about 90 minutes in the morning, 30.86 per cent of boys and 28.99 per cent girls felt slight pain in their lower back which was followed by moderate (12.35% - boys and 5.80% - girls) to very severe pain (6.17% -boys). The onset of pain increased from slight pain to moderate pain for boys (29.63%) and girls (24.64%) before lunch break time. At closing time good percentage of students (boys – 39.50%; girls – 33.33%) went home with moderate pain followed by slight pain (Boys - 23.46 % and girls - 18.84%).

Wrists and Hands: More than one-fourth percentage of students experienced slight pain in their wrists and hands before short break time whereas majority of students had no pain. However, the percentage of students (boys - 38.27 % and girls - 33.33%) who perceived slight pain was increased at BLBT and it decreased (boys - 28.40 % and girls - 21.74%) in the closing time while the number of students reported moderate pain increased to 18.52 per cent for boys and 17.39 per cent for girls at BSCT.

Hip and Thigh: Eighteen percentage of boys suffered slight pain in their hip and thigh region compared to girls (7.25%) before lunch break time. However, a decrease in the percentage of boys (11.11%) reporting slight pain was observed at the end of the closing time.

Knee: There was no pain in the knee for majority of boys and girls throughout the day but the onset of slight pain was indicated by about 22.22 per cent of boys and 17.39 per cent of girls at the end of the school closing time.

Lower Leg: A less percentage of boys (12.35%) and girls (11.59%) experienced slight pain before short break time. By the end of school closing time, the percentage of students experienced slight pain increased to 18.52 per cent of boys and 24.64 per cent of girls.

Further gender wise analysis of variance on discomfort experienced in the form of pain during three time intervals was studied by computing analysis of variance (ANOVA) and presented in the Table 2a and 2b.

Table 1: Perceived Level of Pain Expressed by Selected High School Children at Different Time Intervals in a Day

N =150							
Body Parts	Responses	Before Short Break Time		Before Lunch Break Time		Before School Closing Time	
		Boys (N=81)	Girls (N=69)	Boys (N=81)	Girls (N=69)	Boys (N=81)	Girls (N=69)
Neck	No Pain	40 (49.38)	47 (68.12)	23 (28.40)	31 (44.93)	21 (25.93)	27 (39.13)
	Slight Pain	27 (33.33)	20 (28.99)	43 (53.09)	32 (46.38)	44 (54.32)	34 (49.28)
	Moderate Pain	9 (11.11)	1 (1.45)	12 (14.81)	5 (7.25)	13 (16.05)	8 (11.59)
	Severe pain	4 (4.94)	1 (1.45)	2 (2.47)	1 (1.45)	1 (1.23)	-
	Very Severe Pain	1 (1.23)	-	1 (1.23)	-	2 (2.47)	-
Shoulder	No Pain	56 (69.14)	52 (75.36)	46 (56.79)	45 (65.22)	50 (61.73)	49 (71.01)
	Slight Pain	17 (20.99)	17 (24.64)	27 (33.33)	24 (34.78)	22 (27.16)	19 (27.54)
	Moderate Pain	2 (2.47)	-	4 (4.94)	-	5 (6.17)	1 (1.45)
	Severe pain	3 (3.70)	-	1 (1.23)	-	1 (1.23)	-
	Very Severe Pain	3 (3.70)	-	3 (3.70)	-	3 (3.70)	-
Fore arm	No Pain	62 (76.54)	58 (84.06)	49 (60.49)	46 (66.67)	48 (59.26)	44 (63.77)
	Slight Pain	14 (17.28)	10 (14.49)	23 (28.40)	23 (33.33)	28 (34.57)	25 (36.23)
	Moderate Pain	1 (1.23)	1 (1.45)	7 (8.64)	-	3 (3.70)	-
	Severe pain	2 (2.47)	-	1 (1.23)	-	1 (1.23)	-
	Very Severe Pain	2 (2.47)	-	1 (1.23)	-	1 (1.23)	-
Upper Back	No Pain	42 (51.85)	53 (76.81)	33 (40.74)	43 (62.32)	33 (40.74)	38 (55.07)
	Slight Pain	16 (19.75)	11 (15.94)	22 (27.16)	18 (26.09)	19 (23.46)	14 (20.29)
	Moderate Pain	16 (19.75)	4 (5.80)	19 (23.46)	8 (11.59)	24 (29.63)	17 (24.64)
	Severe pain	2 (2.47)	1 (1.45)	4 (4.94)	-	4 (4.94)	-
	Very Severe Pain	5 (6.17)	-	3 (3.70)	-	1 (1.23)	-
Lower Back	No Pain	39 (48.15)	45 (65.22)	26 (32.10)	32 (46.38)	22 (27.16)	30 (43.48)
	Slight Pain	25 (30.86)	20 (28.99)	23 (28.40)	18 (26.09)	19 (23.46)	13 (18.84)
	Moderate Pain	10 (12.35)	4 (5.80)	24 (29.63)	17 (24.64)	32 (39.51)	23 (33.33)
	Severe pain	2 (2.47)	-	4 (4.94)	2 (2.90)	5 (6.17)	3 (4.35)
	Very Severe Pain	5 (6.17)	-	4 (4.94)	-	3 (3.70)	-
Wrists & Hands	No Pain	45 (55.56)	50 (72.46)	34 (41.98)	41 (59.42)	39 (48.15)	42 (60.87)
	Slight Pain	28 (34.57)	17 (24.64)	31 (38.27)	23 (33.33)	23 (28.40)	15 (21.74)
	Moderate Pain	6 (7.41)	2 (2.90)	11 (13.58)	5 (7.25)	15 (18.52)	12 (17.39)
	Severe pain	-	-	1 (1.23)	-	1 (1.23)	-
	Very Severe Pain	2 (2.47)	-	4 (4.94)	-	3 (3.70)	-
Hip & Thigh	No Pain	68 (83.95)	64 (92.75)	54 (66.67)	63 (91.30)	63 (77.78)	65 (94.20)
	Slight Pain	9 (11.11)	5 (7.25)	15 (18.52)	5 (7.25)	9 (11.11)	4 (5.80)
	Moderate Pain	1 (1.23)	-	9 (11.11)	1 (1.45)	4 (4.94)	-
	Severe pain	1 (1.23)	-	1 (1.23)	-	2 (2.47)	-
	Very Severe Pain	2 (2.47)	-	2 (2.47)	-	3 (3.70)	-
Knee	No Pain	51 (62.96)	60 (86.96)	43 (53.09)	54 (78.26)	48 (59.26)	51 (73.91)
	Slight Pain	13 (16.05)	6 (8.70)	20 (24.69)	10 (14.49)	18 (22.22)	12 (17.39)
	Moderate Pain	9 (11.11)	3 (4.35)	12 (14.81)	5 (7.25)	7 (8.64)	6 (8.70)
	Severe pain	6 (7.41)	-	3 (3.70)	-	5 (6.17)	-
	Very Severe Pain	2 (2.47)	-	3 (3.70)	-	3 (3.70)	-
Lower leg	No Pain	62 (76.54)	60 (86.96)	55 (67.90)	55 (79.71)	56 (69.14)	51 (73.91)
	Slight Pain	10 (12.35)	8 (11.59)	15 (18.52)	12 (17.39)	15 (18.52)	17 (24.64)
	Moderate Pain	4 (4.94)	1 (1.45)	6 (7.41)	2 (2.90)	6 (7.41)	-
	Severe pain	1 (1.23)	-	4 (4.94)	-	1 (1.23)	1 (1.45)
	Very Severe Pain	4 (4.94)	-	1 (1.23)	-	3 (3.70)	-

(Figures in parentheses indicate percentage)

Table 2(a): ANOVA Distribution between Gender and Onset of Pain Experienced by Selected Students in a Day

Onset of Pain Experienced	Boys			Girls			F-Value
	Mean	SD	SE	Mean	SD	SE	
Before Short Break	14.46	5.86	0.514	11.20	2.49	0.557	18.737**
Before Lunch Break	16.14	5.47	0.507	12.77	3.18	0.549	19.95**
End of school closing time	15.99	5.81	0.546	13.33	3.57	0.591	10.545**

** - Significant at 1 per cent level

Table 2(b): ANOVA Distribution between Category of Schools and Onset of Pain Experienced by Selected Students in a Day

Onset of Pain Experienced	Government Schools		Private Schools		F-value
	Mean	SE	Mean	SE	
Before Short Break	11.96	0.542	13.626	0.512	4.985**
Before Lunch Break	14.02	0.537	14.861	0.508	1.282 ^{NS}
End of school closing time	14.17	0.573	15.133	0.542	1.1489 ^{NS}

** - Significant at 1 per cent level; NS – Non Significant

Perceived Pain Experienced between Boys and Girls

It is clear from the data that F-value for boys and girls before short break time was found to be 18.737 (BSBT), 19.95 (BLBT) and 10.545 (BSCT) and it was statistically significant at one percent level, indicating boys and girls differed in experiencing the bodily discomfort in the form of pain (Table 2 a). Also the discomfort experienced before short break for boys with mean of 14.46 was significantly higher than girls with the mean value of 11.20. Similarly mean scores of boys at the time of before lunch break (mean: 16.14) and before school closing time (mean: 15.99) was significantly higher than girls.

Perceived Pain Experienced between Government and Private School Students

The perceived pain experienced by students with respect to category of schools was studied and the data revealed that the onset of pain experienced between government school and private school students before short break time in the morning was found to be significant at one percent level with F-value of 4.985 (Table 2b). It was more among private school students with mean of 13.626 than government school students (mean: 11.96). However, no significant variation was observed before lunch break time and before school closing time.

Table 3: Percentage Distribution of Perceived Level of Pain While Using Existing and Developed Prototype Classroom Furniture

Body Parts	Responses	BSBT				BLBT				BSCT			
		Boys (N=14)		Girls (N=16)		Boys (N=14)		Girls (N=16)		Boys (N=14)		Girls (N=16)	
		EF	DPF	EF	DPF	EF	DPF	EF	DPF	EF	DPF	EF	DPF
Neck	No Pain	4 (28.57)	14 (100)	6 (37.50)	16 (100)	4 (28.57)	12 (85.71)	1 (6.25)	14 (87.50)	5 (35.71)	12 (85.71)	1 (6.25)	15 (93.75)
	Slight Pain	7 (50.00)	-	9 (56.25)	-	8 (57.14)	2 (14.29)	15 (93.75)	2 (12.50)	7 (50.00)	2 (14.29)	13 (81.25)	1 (6.25)
	Moderate Pain	2 (14.29)	-	1 (6.25)	-	2 (14.29)	-	-	-	2 (14.29)	-	2 (12.50)	-
	Severe pain	1 (7.14)	-	-	-	-	-	-	-	-	-	-	-
	Very Severe Pain	-	-	-	-	-	-	-	-	-	-	-	-
Shoulder	No Pain	11 (78.57)	14 (100)	8 (50.00)	16 (100)	10 (71.43)	14 (100)	7 (43.75)	16 (100)	11 (78.57)	14 (100)	8 (50.00)	16 (100)
	Slight Pain	2 (14.29)	-	8 (50.00)	-	1 (7.14)	-	9 (56.25)	-	2 (14.29)	-	8 (50.00)	-
	Moderate Pain	-	-	-	-	2 (14.29)	-	-	-	-	-	-	-
	Severe pain	1 (7.14)	-	-	-	1 (7.14)	-	-	-	1 (7.14)	-	-	-
	Very Severe Pain	-	-	-	-	-	-	-	-	-	-	-	-
Forearm	No Pain	11 (78.57)	14 (100)	12 (75.00)	16 (100)	11 (78.57)	14 (100)	9 (56.25)	16 (100)	11 (78.57)	14 (100)	12 (75.00)	16 (100)
	Slight Pain	3 (21.43)	-	4 (25.00)	-	3 (21.43)	-	7 (43.75)	-	3 (21.43)	-	4 (25.00)	-
	Moderate Pain	-	-	-	-	-	-	-	-	-	-	-	-
	Severe pain	-	-	-	-	-	-	-	-	-	-	-	-
	Very Severe Pain	-	-	-	-	-	-	-	-	-	-	-	-
Upper Back	No Pain	5 (35.71)	12 (85.71)	12 (75.00)	16 (100)	6 (42.86)	11 (78.57)	7 (43.75)	16 (100)	9 (64.29)	13 (92.86)	12 (75.00)	16 (100)
	Slight Pain	5 (35.71)	2 (14.29)	3 (18.75)	-	4 (28.57)	3 (21.43)	7 (43.75)	-	1 (7.14)	1 (7.14)	3 (18.75)	-
	Moderate Pain	3 (21.43)	-	1 (6.25)	-	2 (14.29)	-	2 (12.50)	-	3 (21.43)	-	1 (6.25)	-
	Severe pain	-	-	-	-	2 (14.29)	-	-	-	-	-	-	-
	Very Severe Pain	1 (7.14)	-	-	-	-	-	-	-	1 (7.14)	-	-	-

Lower Back	No Pain	9 (64.29)	13 (92.86)	7 (43.75)	14 (87.50)	4 (28.57)	13 (92.86)	3 (18.75)	15 (93.75)	9 (64.29)	13 (92.86)	7 (43.75)	16 (100)
	Slight Pain	3 (21.43)	1 (7.14)	9 (56.25)	2 (12.50)	6 (42.86)	1 (7.14)	7 (43.75)	1 (6.25)	3 (21.43)	1 (7.14)	9 (56.25)	-
	Moderate Pain	1 (7.14)	-	-	-	2 (14.29)	-	6 (37.50)	-	1 (7.14)	-	-	-
	Severe pain	1 (7.14)	-	-	-	2 (14.29)	-	-	-	1 (7.14)	-	-	-
	Very Severe Pain	-	-	-	-	-	-	-	-	-	-	-	-
Wrists & Hands	No Pain	7 (50.00)	14 (100)	8 (50.00)	16 (100)	4 (28.57)	12 (85.71)	5 (31.25)	16 (100)	7 (50.00)	14 (100)	8 (50.00)	16 (100)
	Slight Pain	6 (42.86)	-	7 (43.75)	-	6 (42.86)	2 (14.29)	10 (62.50)	-	6 (42.86)	-	7 (43.75)	-
	Moderate Pain	1 (7.14)	-	1 (6.25)	-	3 (21.43)	-	1 (6.25)	-	1 (7.14)	-	1 (6.25)	-
	Severe pain	-	-	-	-	-	-	-	-	-	-	-	-
	Very Severe Pain	-	-	-	-	1 (7.14)	-	-	-	-	-	-	-
Hip & Thigh	No Pain	12 (85.71)	14 (100)	13 (81.25)	16 (100)	7 (50.00)	14 (100)	14 (87.50)	16 (100)	12 (85.71)	14 (100)	13 (81.25)	16 (100)
	Slight Pain	2 (14.29)	-	3 (18.75)	-	4 (28.57)	-	2 (12.50)	-	2 (14.29)	-	3 (18.75)	-
	Moderate Pain	-	-	-	-	3 (21.43)	-	-	-	-	-	-	-
	Severe pain	-	-	-	-	-	-	-	-	-	-	-	-
	Very Severe Pain	-	-	-	-	-	-	-	-	-	-	-	-
Knee	No Pain	7 (50.00)	14 (100)	13 (81.25)	16 (100)	6 (42.86)	14 (100)	11 (68.75)	16 (100)	7 (50.00)	14 (100)	13 (81.25)	16 (100)
	Slight Pain	4 (28.57)	-	1 (6.25)	-	4 (28.57)	-	2 (12.50)	-	4 (28.57)	-	1 (6.25)	-
	Moderate Pain	1 (7.14)	-	2 (12.50)	-	3 (21.43)	-	3 (18.75)	-	1 (7.14)	-	2 (12.50)	-
	Severe pain	2 (14.29)	-	-	-	1 (7.14)	-	-	-	2 (14.29)	-	-	-
	Very Severe Pain	-	-	-	-	-	-	-	-	-	-	-	-
Lower Leg	No Pain	10 (71.43)	14 (100)	13 (81.25)	16 (100)	8 (57.14)	14 (100)	12 (75.00)	16 (100)	10 (71.43)	14 (100)	13 (81.25)	16 (100)
	Slight Pain	1 (7.14)	-	3 (18.75)	-	3 (21.43)	-	3 (18.75)	-	4 (28.57)	-	3 (18.75)	-
	Moderate Pain	1 (7.14)	-	-	-	1 (7.14)	-	-	-	-	-	-	-
	Severe pain	1 (7.14)	-	-	-	2 (14.29)	-	1 (6.25)	-	-	-	-	-
	Very Severe Pain	1 (7.14)	-	-	-	-	-	-	-	-	-	-	-

(Figures in Parentheses indicate percentage)

EF – Existing Furniture; DPF – Developed Prototype Furniture

Perceived Level of Pain Experienced by Selected Ninth Standard School Children While Using Existing and Developed Prototype Classroom Furniture

The perceived level of pain experienced on various body parts of selected students while using the existing and developed prototype classroom furniture was obtained and presented in Table 3. The data for perceived level of pain while using existing classroom furniture for the selected 30 students who participated in the perceived level of pain discomfort experienced was obtained from the Table 1. Each selected student was provided with the developed prototype furniture for one school day and their perceived level of pain was studied on 5 point scale at three intervals viz., Before short break time (BSBT), before lunch break time (BLBT) and before school closing time (BSCT)

Neck: It is clear from the data that pain on the neck part while using the existing furniture was reported as slight pain by almost equal percentage of boys (50.00%) and girls (56.25%) during BSBT. The percentage of students reported slight pain was increased to 57.14 per cent of boys and 93.75 per cent of girls at BLBT whereas by the end of closing time about 50 per cent of boys and 81.25 per cent of girls expressed slight pain. Although gender wise no difference was found during BSBT but the percentage of girls reported about onset of slight pain was more as against their counterpart during BLBT and BSCT. Thus, it is noticed as the day advances the percentage of students reported pain was found to be increased. However, cent per cent of boys and girls reported no pain while using developed prototype furniture during all the three intervals. Also the percentage of slight pain discomfort reported was negligible.

Shoulder: With regard to the pain on the shoulder part while using the existing furniture, more than three-fourth percentage of boys had no pain during all the three intervals of the day whereas the perceived level of pain reported by girls was found to be slight pain. Fifty per cent of girls reported slight pain during BSBT and the percentage increased to 56.25 per cent during BLBT further it was 50 per cent at BSCT. However, cent per cent of selected boys and girls had no pain during all the three intervals while using the developed prototype furniture.

Forearm: The perceived level of pain on the forearm region while using existing furniture was found to be slight pain for 21.43 per cent of boys during all the three intervals. The percentage of girls' experienced slight pain was found to be 25 per cent during BSBT and increased to 43.75 per cent at BLBT and then decreased to 25 per cent during BSCT. However, the perceived level of pain was found to be nil for cent per cent of boys and girls while using developed

prototype furniture at all the three intervals.

Upper Back: Regarding pain on the upper back, the selected students perceived level of pain varied from no pain to very severe pain while using the existing furniture. The percentage of boys reported slight pain was found to be 35.71 per cent during BSBT, and it was 28.75 per cent by lunch break time. The percentage of boys reported moderate pain was found to be 21.43 per cent during BSBT, and it was decreased to 14.29 per cent by lunch break time and further increased to 21.43 per cent by school closing time. In case of girls, majority of them (75.00%) expressed no pain during BSBT whereas 43.75 per cent of girls reported slight pain followed by 12.50 per cent indicated moderate pain during BLBT. However, the percentage of girls reported no pain (75.00%) was found to be more during BSCT. The perceived pain discomfort while using developed prototype furniture was found to be no pain for more than three-fourth percentage of boys and cent per cent of girls during all the three intervals of the day. The percentage of boys reported slight pain was found to be less during BLBT (21.43%).

Lower Back: Majority of boys (64.29%) reported no pain followed by slight pain (21.43%) in their lower back during BSBT while using existing furniture. The percentage of boys expressed slight pain increased to 42.86 per cent during BLBT and became 21.43 per cent during BSCT. However, the percentage of girls revealed slight pain was 56.25 per cent during BSBT and BSCT, 43.75 per cent during BLBT indicating that almost fifty per cent of the selected girls reported slight pain during the three intervals. In developed furniture, majority of boys (92.86%) felt no pain and a negligible percentage of boys (7.14%) indicated slight pain during all the three intervals. Similarly, majority of girls reported no pain during all the three intervals, it was found to be increased also *i.e.*, 87.50 per cent during BSBT, 93.75 per cent during BLBT and cent per cent during BSCT.

Wrists and Hands: Perceived level of pain in the wrists and hands was found to be slight for 42.86 per cent of boys while using existing furniture during all the three intervals and the percentage of boys reported moderate pain was 21.43 per cent during BLBT. Similarly, the percentage of girls reported slight pain was 43.75 per cent, 62.58 per cent and 43.75 per cent during the BSBT, BLBT and BSCT respectively. However, for the developed furniture, cent per cent of boys and girls reported no pain during all the three intervals except few boys (14.29%) expressed slight pain in their wrists and hands during BLBT.

Hip and Thigh: Majority of boys (85.71%) revealed no pain in their hip and thigh region during BSBT and BSCT while using existing furniture and the percentage of boys reported slight pain and moderate pain during BLBT was 28.57 per cent and 21.43 per cent respectively. Similarly, the percentage of girls reported no pain was found to be more and it was 81.25 per cent during BSBT and 87.50 per cent during BLBT. A negligible percentage of girls expressed slight pain during all the three intervals. In case of developed prototype furniture, cent per cent of boys and girls reported no pain during all the three intervals of the day.

Knee: The perceived level of pain in the knee region while using existing furniture was found to be slight pain for 28.57 per cent of boys during all the three intervals and moderate pain for 21.43 per cent of boys during BLBT. Majority of girls reported no pain and less percentage of them felt slight pain to moderate pain during the three intervals. However, cent per cent of boys and girls revealed no pain while using developed furniture throughout the day.

Lower Leg: The pain discomfort in the lower leg while using existing furniture was no pain for 71.43 per cent of boys at BSBT and the onset of slight pain was found to be experienced by 21.43 per cent at BLBT and the percentage

increased to 28.57 per cent at BSCT. For girls, majority of them (75.00%) indicated no pain followed by slight pain (18.75%) during the three intervals. However, cent per cent of both the gender revealed no pain while using developed furniture throughout the day.

Table 4, indicates the data of mean score of upper body parts viz., neck, shoulder, forearm, upper back, lower back, wrists and hands and lower body parts viz., hip and thigh, knee and lower leg. It is clear from the data that boys and girls experienced slight pain in their upper body parts while using existing furniture whereas it was no pain in developed prototype furniture. However, for lower body parts, boys experienced slight pain at BSBT and BLBT, it decreased to no pain at BSCT and girls had no pain during the day. In general, boys experienced slight body pain at BSBT and BLBT whereas for girls, onset of slight pain started at BLBT while using the existing classroom furniture. In case of developed prototype furniture, both boys and girls had no body pain throughout the day.

Table 4: Mean Score of Pain Discomfort in Upper and Lower Body Parts of Students While Using Existing and Developed Classroom Furniture

Body Parts	Gender	Existing Furniture			Developed Prototype Furniture		
		BSBT	BLBT	BSCT	BSBT	BLBT	BSCT
Upper body parts	Boys	1.53	1.78	1.54	1.00	1.07	1.02
	Girls	1.49	1.76	1.54	1.04	1.07	1.04
Lower body parts	Boys	1.59	1.78	1.39	1.00	1.00	1.00
	Girls	1.21	1.30	1.21	1.00	1.00	1.00
Total (Both upper & lower body)	Boys	1.55	1.78	1.49	1.00	1.05	1.02
	Girls	1.39	1.60	1.43	1.03	1.04	1.03

Degree of Perceived Pain Discomfort – No pain (1) –1.0 to 1.49;

Slight pain (2) – 1.5 to 2.49;

Moderate pain (3) – 2.5 to 3.49;

Severe pain (4) – 3.5 to 4.49;

Very severe pain (5) – 4.5 to 5

Table 5: Paired – t Test Values for Perceived Pain Discomfort While Using Existing and Developed Prototype Classroom Furniture

			N = 30
Gender	Existing Furniture	Developed Prototype Furniture	T-Value
Boys (n = 14)	44.43	28.07	8.47**
Girls (n = 16)	40.00	27.38	10.71**

** Significant at 1 percent level

Table 5 reveals the statistical analysis of perceived level of pain discomfort experienced by the selected students between existing and developed classroom furniture, by using paired t-test. It is clear from the result that perceived level of pain for both the genders between the two types of furniture was found to be significant at 1 per cent level. The observed mean for boys using existing furniture was found to be 44.43 and 28.07 while using developed prototype furniture whereas for girls it was 40.00 in existing furniture and 27.38 in developed prototype furniture. It indicated that the difference in the pain experienced while using existing furniture and developed prototype furniture was significant in case of both boys and girls.

CONCLUSIONS

The results of the study revealed that that majority of selected boys and girls reported no body pain while using developed prototype furniture whereas the perceived level of pain was found to be slight pain for majority of boys and girls while using existing classroom furniture. Further, the pain discomfort expressed by the students between two types of furniture was found to be statistically significant indicating that students experienced more pain in existing classroom furniture than in developed prototype classroom furniture. It can be concluded that there is a need to introduce ergonomically designed classroom furniture for improved comfort of the users.

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